

USDA FY 2012 AVOIDING HARM FROM INVASIVE SPECIES (USDA Do No Harm 2012 Report)

A USDA Report to the Invasive Species Advisory Committee and the National Invasive Species Council by Hilda Diaz-Soltero, USDA Senior Invasive Species Coordinator

December 18, 2012

There are eight U.S. Department of Agriculture (USDA) agencies that work on invasive species issues: the Agricultural Research Service (ARS); Animal Plant Health Inspection Service (APHIS); National Institute for Food and Agriculture (NIFA) (formerly the Cooperative State Research, Education and Extension Service (CSREES)); Economic Research Service (ERS); Farm Service Agency (FSA); Foreign Agricultural Service (FAS); USDA Forest Service (FS) and Natural Resources Conservation Service (NRCS).

Previous USDA Do No Harm Reports cover: (1) fiscal year (FY) 2004 activities; (2) FY 2005 activities for ARS, APHIS, CSREES, ERS and NRCS (first report dated October 2004); (3) FY 2005 activities for the Forest Service (report dated February 2005); (4) FY 2006 activities for ARS/NAL, CSREES, ERS, NRCS and USFS (report dated March 2007); (5) FY 2006 activities for APHIS (report dated August 20, 2007); FY 2006 activities for ARS (report dated September 22, 2007); (6) FY 2007 activities for APHIS, ARS, ARS/NAL, APHIS, CSREES, ERS, FAS, FS and NRCS (report dated 20 March 2008); (7) FY 2008 activities for APHIS, ARS, ARS/NAL, APHIS, CSREES, ERS, FAS, FS and NRCS (report dated March 3, 2009); (8) FY 2009 activities for ARS, ARS/NAL, APHIS, NIFA, ERS, FS and NRCS (report dated February 17, 2010); (9) FY 2010 activities for ARS, ARS/NAL, APHIS, NIFA, ERS, USFS and NRCS (report dated 14 March 2011); and (10) FY 2011 activities for ARS, ARS/NAL, APHIS, NIFA, ERS, USFS and NRCS (report dated 27 Feb 2012).

This is the twelfth “USDA Do No Harm Report” to the Invasive Species Advisory Committee and the National Invasive Species Council. It covers the FY 2012 activities for ARS, ARS/NAL,

APHIS, NIFA, ERS, USFS and NRCS. The report is dated December 18, 2012.

The report is divided by agency activities. Each agency will report on:

- a) Invasive species program activities the agency is carrying out to do no harm;
- b) The way in which, when the agency carries out other programs activities, they are also designed and implemented to do no harm;
- c) Activities that are doing harm and future actions the agency will take to change the activities so that they do no harm.

Within the above categories, the agency will include its own agency activities, as well as activities where the agency is coordinating and/or collaborating with another federal agency, per the mandate of the Invasive Species Executive Order (EO 13112).

I. USDA Research Agencies:

A. Agricultural Research Service (ARS)

The **Agricultural Research Service (ARS)** Agricultural Research Service (ARS) is the principal in-house research agency of the USDA. With a staff of over 8,000 employees, ARS carries out research at over 100 laboratories throughout the Nation and in several foreign countries. ARS research is organized under four broad categories: Animal Production and Protection; Nutrition, Food Safety, and Quality; Crop Production and Protection; and Natural Resources and Sustainable Agricultural Systems. Pest management, including invasive species, is a major research component across all these areas. Research infrastructure dedicated to pest management includes personnel and facilities in domestic and foreign laboratories that also provide support to other agencies, organizations, and state governments. ARS is committed to performing its research programs and projects in a manner that does not cause or promote the introduction or spread of invasive species in the U.S. or elsewhere, ensuring that all feasible and prudent measures are taken to minimize risk of harm.

1. Activities that do no harm

A. Informational Activities.

- **e-Government and Public Communication Initiatives.**
USDA's National Invasive Species Information Center (NISIC) at the National Agricultural Library (NAL) maintains and manages the www.invasivespeciesinfo.gov Web site as a reference gateway to information, organizations, and services about invasive species. The Center supports the work of the U.S. Department of Agriculture and the National Invasive Species Council in meeting the information requirements of the [Executive Order 13112](#). The Center and its Web site serve a broad customer base, from students, to farmers, researchers, and government officials.
- As the resources available through NISIC continue to increase, the site maintains its reputation as authoritative portal for identification of, and access to Federal invasive species resources and activities. The www.invasivespeciesinfo.gov Web site is frequently cited in many news articles as a good source of invasive species information. NISIC's Web site consistently is ranked highly in all major search engines and is linked to many invasive species related Web sites (Federal, State, International, and non-profit organizations).
- NISIC maintains a high quality online web presence and provides reference services to a wide variety of stakeholders (local, state, tribal, federal managers, scientists, policy-makers, landowners and land managers, agricultural producers, teachers, students, media journalists, and others), with very limited staff resources (1.11 FTE).
- **FY 2012 Statistics Summary:**
 - Reference Requests:
 - NISIC received 444 reference requests in FY 2012 (as compared to 340 requests in FY 2011).
 - Web Statistics:
 - [NISIC Web site](#) – 4.7 million page views (+2% increase from previous year); 1.8 million unique visitors (+19% increase from previous year)

Note: Problem with server log files Feb-Apr 2012; numbers estimated during these months.

- [NISIC What's New Blog](#) – 525k page views (+36% increase; 300 unique visitors (+140% increase))
- [ITAP Web site](#) – 411k page views (+355% increase); 80k unique visitors (+466% increase)
- [Invasiveinfo](#) Twitter Stats:
 - Total followers – 1305 (+6% increase from FY 2011)
 - Total lists – 101 lists (+29% increase from FY 2011)
- **Reference Requests:**

The types of questions NISIC received routinely range broadly from students to international researchers, general public, media, and other government agency personnel. NISIC received reference requests from a variety of patrons in FY 2012, including:

 - The Communications Manager from the California Association of Winegrape Growers asked for current information on the stink bug issue to include in a newsletter for their members.
 - A USDA, Forest Service Program Leader seeking information for Japanese stiltgrass.

"Thanks, when looking on the web, there was a lot of information to choose from, and you helped narrow it down for me. Thanks for the very prompt reply. It restores my faith that some of us in the government don't conduct business at a snail's pace."
 - A science writer from Science Magazine contacted NISIC asking us to highlight an upcoming live chat discussing invasive species issues on our site.
 - A landscape architect contacted NISIC seeking definitive resources that state which resources are considered invasive for LEED certification purposes for a landscape project at Princeton University.

"My sincere thanks for the time and effort you put into this request. It is rare that one ever runs across someone like yourself that thoroughly applies their self to the task at hand and is so graciously helpful. We will make the contacts you have recommended in our search for alternatives. Thanks again."

- A team leader for a group of 8th graders who participated in eCYBERMISSION (Army sponsored web-based science competition to explore and propose a solution to a real community problem) seeing information on zebra mussels.

"your help was invaluable to the girls on our team, and they won first place in the state of Maryland and were in the top four for the Northeast region. While they did not win the region, they did extremely well. We hope their project sparks some interest in adding filters to bilge pumps and have forwarded their information to the pump company."

- **FY 2012 NISIC Information Products and Enhancements:**

- **Smartphone Application Resources** – NISIC created a new page which provides information for Smartphone applications (and other mobile devices) to assist in tracking, monitoring various species, including invasive species.
- **Identification Resources** – NISIC created a new section which provides general resources to help identify unknown species that may be invasive. Species identification is important in helping gardeners, land managers, and landscape architects identify invasive species that can be harmful to local habitats.
- **New Content** – NISIC frequently added new relevant content for many site topics including: invasive species bills, federal and state press releases, management plans, grants and funding opportunities, conferences and events, education for professionals, specific profiles resources, and much more. NISIC developed new species profiles for current species of interest, such as Burmese python, beech bark disease, chestnut blight, and others.
- **Twitter** – NISIC continued using Twitter ([InvasiveInfo](#)) incorporating their customized Invasive News feed and NISIC's What's New feed automatically, as well as adding custom tweets.
Notable followers include: @usdafsa - USDA, Farm Service Agency; @WoWExpress - USFWS, Watershed on Wheels, @CALSRResearch - North Carolina

Agricultural Research Service; @nataglaw, The National Agricultural Law Center; @NFinFloridaf, USDA, FS, National Forests in Florida and many others.

- **Social Bookmarking** – NISIC uses a social bookmarking widget on Web site pages which allows users to easily add NISIC pages to various common social bookmarking sites. This utility enables NISIC to monitor additional statistics and extend its outreach.
- **RSS Feeds** – NISIC provides customized RSS feeds for What's New on Our site, Invasive Species News, Invasive Species Related Grants (Grants.gov), Invasive Species Journal (Invasive Plant Science and Management), and various Emerging Issues feeds. Hundreds of Subscribers receive NISIC's various daily email updates. Subscribers to NISIC's email updates include users from many Federal and State agencies, universities and school systems.

- **NISIC Hosts Unique Content:**

- Extensive [Invasive Species Conference Calendar](#)
 - Includes Global and all tax related conferences
 - Many sites link to NISIC's calendar, instead of creating/maintaining their own resource
- Provides relevant invasive species information across Federal agencies (highlighting Federal press releases, USDA blog items, Federal Register notices, invasive species legislation, grants and funding, etc).
- NISIC Site Hosted Content:
 - **USDA Reports:**
 - USDA Do No Harm Reports to the Invasive Species Advisory Committee (ISAC) and the National Invasive Species Council
 - USDA Reports to the Invasive Species Advisory Committee (ISAC)
 - USDA Grants Workbook (updated yearly) – U.S. Department of Agriculture Grant and Partnership Programs that Can Address Invasive Species Research, Technical Assistance, Prevention and Control

- **2010 Microbial Biocontrol Symposium of Arthropods, Weeds, and Plant Pathogens: Risks, Benefits and Challenges (Presentations, Presentation Summaries and Movies)**
 - **Various additional reports and conference proceedings not hosted elsewhere**
- **NISIC Supports USDA/ARS and Other Federal Initiatives**
 - **National Invasive Species Council Support.**
NISIC continued to support the activities of National Invasive Species Council by posting relevant information and as requested by Hilda Diaz-Soltero, USDA Senior Invasive Species Coordinator (conferences, federal register notices, Invasive Species Advisory Committee information, etc), as well as additional information from the Federal Agencies representing the National Invasive Species Council.
 - **Other e-Government and Public Communication Initiatives.** Invasivespeciesinfo.gov Web site links: NISIC's Web site links to the 13 Federal Agencies that are members of the National Invasive Species Council, as well as links to the many Agency specific programs and resources relevant to invasive species issues. NISIC also includes extensive resources for State, Professional and Non-Profit, and International programs with an interest in the prevention, control, or eradication of invasive species.
 - **Information management support to ITAP.**
NISIC provides technical and information management support for the Federal Interagency Committee for Invasive Terrestrial Animals and Pathogens (ITAP), a Federal scientific and technical interagency advisory group. This includes:
 - Web site – www.itap.gov (developed, maintained and hosted at NAL)
 - Supports SharePoint a secure Web-based internal communication platform.
 - Listserv for committee-wide communication.

2. Other ARS Research activities also designed to do no harm:

Invasive species information portal: The National Agricultural Library's National Invasive Species Information Center (invasivespeciesinfo.gov) Web site provides an information gateway to invasive species information; covering Federal, State, local and international sources.

Information management support to ITAP: The National Agricultural Library's National Invasive Species Information Center provides technical and information management support for ITAP, the Federal Interagency Committee for Invasive Terrestrial Animals and Pathogens (itap.gov), a Federal scientific and technical interagency advisory group.

B. ARS Research Activities

Plant Diseases

Sudden oak death fungus soil remediation. *Phytophthora ramorum* causes sudden oak death and also seriously impacts the commercial nursery industry due to losses resulting from quarantine issues. The nursery industry badly needs new methods of control of *P. ramorum* so that infested nurseries can be removed from quarantine status and resume normal production. ARS researchers at Fort Detrick, Maryland, demonstrated for the first time in a nursery setting that the beneficial biocontrol fungus *Trichoderma asperellum*, grown on wheat bran and raked into nursery test-plot soil, can reduce *P. ramorum* soil populations to non-detectable levels after six weeks. California regulatory agents confirmed these results at a commercial nursery, and the nursery was lifted from quarantine status. The new method will have wide applicability in reducing losses to the nursery industry due to *P. ramorum*, and technology transfer is underway to facilitate development of a commercial formulation of the biocontrol fungus.

Diagnostic test for the new boxwood blight pathogen. The recent rapid emergence and spread of boxwood blight disease in the United States places the nursery and landscape industry at substantial risk.

Boxwood is a high value ornamental nursery crop valued at \$103 million annually. Early and rapid detection of *Calonectria pseudonaviculata* in plants and soil is needed to prevent the spread of this emergent disease which threatens the health and production of U.S. boxwood. ARS scientists in Beltsville, Maryland, developed a DNA-based boxwood blight diagnostic assay capable of detecting the presence of the causal agent of boxwood blight disease. This diagnostic test will be used by plant scientists developing methods to halt the spread of boxwood blight and to develop control measures for the disease.

Extensive cereal disease evaluation protects U.S. wheat and barley from stripe rust losses. Cereal rust expertise provided by ARS researchers in Pullman, Washington, was applied in 2012 to protect the wheat and barley crop from new, emerging strains of the stripe rust fungus. During the 2012 growing season, ARS scientists at Pullman evaluated more than 18,000 wheat and 5,000 barley lines for resistance to stripe rust in the field, and hundreds were also tested in the greenhouse with cultured stripe rust strains. This enabled U.S. wheat and barley breeders to select lines for advancing new varieties with resistance to new stripe rust strains. The results of the extensive evaluation combined with molecular marker analysis in FY12 resulted in the advancement and release of more than 10 new wheat and barley varieties with increased stripe rust protection

High yielding soybean with resistance to multiple cyst nematode populations. In the United States, nearly a billion dollars are lost in annual soybean production due to a tiny root parasite, soybean cyst nematode. Cultivars with genetically controlled resistance will reduce these losses. ARS researchers at Jackson, Tennessee, in cooperation with the Tennessee Agricultural Experiment Station, released soybean germplasm line JTN-5203 with resistance to multiple pathogens endemic to the mid-southern United States, combined with high yield potential. Traditional breeding methods were combined with modern marker assisted biotechnology techniques for rapid advancements. Soybean JTN-5203 will be highly useful as parent material in breeding programs for providing more durable resistance, especially to soybean cyst nematode, while maintaining very high yield potential in development of new cultivars.

It can also be grown directly as an excellent conventional soybean cultivar in the mid-southern United States.

Optimizing disease management strategies for HLB (citrus greening) in Florida. An epidemiological model to predict the spatial and temporal dynamics of citrus Huanglongbing (HLB) from infected areas of South Florida, which can be used to test various disease control strategies, was finalized and validated. A web-based version of the model has also been developed for non-researcher use. For example, the model output suggests that controlling secondary infections by diseased tree removal and insecticide applications, plus controlling primary infection from new insect immigrations through area-wide control strategies, can reduce disease increase to a manageable 2 to 5% increase per year, which appears to be economically sustainable.

Preplant IPM strategy for managing root-knot nematode in peach. Peach growers in the Southeast often find it an economic hardship to apply fumigants to orchard sites. Finding a nonchemical alternative to preplant chemical control of nematode pests is warranted. ARS researchers at Byron, Georgia, and Beltsville, Maryland, evaluated a tall fescue grass cultivar as a preplant rotation for suppressing the Southern root-knot nematode. Trees planted after a 1-year or 2-year tall fescue grass cover crop and planted in fumigated soil are significantly larger than trees in unfumigated soil. This work provides the essential baseline data needed to develop a nonchemical preplant nematode control recommendation that now appears in the *2012 Southeastern Peach, Nectarine, and Plum Pest Management and Culture Guide*.

Soybean dwarf virus is limited by the aphid vector in the United States. Soybean dwarf virus (SbDV), which significantly affects soybean crops in Japan and other Asian countries, has been identified in multiple locations within the United States. Outbreaks of SbDV in the United States have always been limited, perhaps because the primary aphid colonizing soybean (*Aphis glycines*) is reported to be a poor vector of SbDV. An experimental analysis conducted by ARS researchers at Frederick, Maryland, demonstrated that specific mutations must occur in U.S. isolates to enable soybean outbreaks, and these mutations tend to prevent effective transmission

of SbDV. This work demonstrates that SbDV outbreaks in the United States would require adaptation of the virus to the vector, and that risks associated with SbDV for U.S. soybean production are limited.

Soybean mosaic virus (SMV) genome regions required for aphid and seed transmission. *Soybean mosaic virus* (SMV) is transmitted by aphids and through seed, and can cause yield reductions as high as 35% in soybean. SMV-infected seeds serve as the primary source of inoculum for the virus in North America and secondary spread occurs by aphids. ARS researchers at Urbana, Illinois, and scientists at the University of Illinois studied the role of virus-encoded proteins in aphid and seed transmission, severity of foliar symptoms, and induction of seed coat mottling. Two virus proteins previously associated with aphid transmission were shown to also be required for efficient seed transmission, and this discovery suggests that interactions of the two proteins are important for multiple functions in the virus life cycle. In addition, two other regions within the SMV genome were shown to affect transmission through seed and the presence of seed-coat mottling in virus-infected seeds. The information will be useful to pathologists and virologists for development of novel methods to disrupt disease.

Crop Production

RNAi technology – a new strategy for controlling infectious diseases and parasites of bees. Israeli acute paralysis virus is a suspected cause of Colony Collapse Disorder (CCD). ARS scientists in Fort Pierce, Florida, in collaboration with university, industry (Beeologics/Monsanto), and military partners, have successfully developed a new control strategy that uses RNA interference (RNAi) technology to protect bees against the virus. The RNAi product protects bees when fed in sugar solutions routinely used by beekeepers as a honey substitute. This RNAi strategy not only controls this virus, and thus has potential for reducing CCD, but could also be adapted to target and control other diseases and pests of bees and other insects. World-wide, this was the first large-scale field proof-of-concept use of RNAi for pest control. The bee treatment product is now commercialized as Remebee©.

Bees with varroa sensitive hygiene trait resistance against varroa mite commercialized. Varroa mite is the most important pest of honey bees. While miticides partially control the mite, some bees are resistant and there is need for additional tools. ARS scientists in Baton Rouge, Louisiana, found that some lines of bees remove mite-infested brood from hives. They named the trait varroa sensitive hygiene (VSH), and commercialized VSH-bee lines. Twenty-five percent honey bee queens now being sold contain the VSH trait. This success resulted in one of the top U.S. awards for technology transfer, a Federal Laboratory Consortium Award for Excellence in Technology Transfer in 2012 for ARS.

New protocols for spray drift reduction. Numerous new spray technologies including nozzles, spray formulations, adjuvants, and operational practices may significantly reduce spray drift potential, a critical concern for aerial applicators. There is a need to standardize measurement and evaluation methods so as to provide science-based guidance to applicators for enhancing drift reduction. In cooperation with EPA and other research and manufacturing entities, ARS scientists in College Station, Texas, refined and tested protocols to evaluate droplet size and drift of aerially applied spray using drift reduction technologies. Objective criteria were used to quantify the performance of drift reduction technologies, and large-scale model simulations provided guidance on best operational practices such as droplet size, swath offset, and application height. These new protocols will be used by applicators to counter meteorological and other in-field conditions that can elevate drift potential. The results will be better on-target deposition of aerial sprays, less drift, and more environmentally sensitive utilization of agricultural chemicals.

Commercializing Russian honey bee lines resistant to parasites, pests, and pathogens. ARS researchers in Baton Rouge, LA, found honey bees in Russia with some resistance to varroa mite. Once imported to the United States, the bees were intensively selected to produce a varroa-resistant stock. The bee also was found to be very resistant to tracheal mites and American foulbrood, somewhat resistant to nosema, and to harbor fewer small hive beetles than the standard Italian bee colonies. There are two mechanisms of varroa resistance: Russian bees uncap and remove the mite from infested brood cells and through frequent auto-grooming. Tracheal mite

resistance is dependent on a few major dominant genes interacting with minor genes. These advances in understanding resistance makes it possible to establish a breeding stock and, potentially, to develop marker-assisted breeding. ARS lines of Russian bees are now being used by the bee industry, with 14 commercial bee breeders having certified pure Russian stock. Several commercial honey producer/pollinators also have Russian queens and are creating their own breeding stock. Russian queens clearly now play an integral role in a pesticide-resistance management program by controlling multiple hive pests and reducing the pressure to use miticides.

Bee health possibly affected by pesticide-fungicide and pesticide-pathogen interactions. In a comprehensive survey, ARS scientists and university collaborators found 98 pesticides in the beeswax and pollen of dying and healthy colonies alike, revealing the complexity of pesticide interactions. The study highlighted the persistence of some products used to control hive pests, especially miticides for control of varroa mite. The sublethal effects of pesticides and their synergistic interactions with other bee mortality factors are prime suspects in Colony Collapse Disorder (CCD). Two results of ARS research support the need to continue this line of inquiry. (i) A fungicide (Vanguard) used by almond growers in California was found to interact with a miticide (Hivastan, fenpyroximate), to increase bee mortality. These results, from ARS in Weslaco, TX, support previous findings that pesticide-fungicide interactions can overload cytochrome P450 detoxification mechanisms in bees, and suggests that one or the other product (i.e., either the fungicide or miticide) should not be used during bloom. (ii) Honey bee adults exposed to sublethal doses of imidacloprid (a neonicotinoid insecticide) developed higher levels of nosema spores than did nonexposed bees. The research, performed in Beltsville, MD, showed reduced queen emergence and higher virus levels in colonies fed virus-contaminated pollen. Thus, pesticides, even at sublethal exposure levels, might affect honey bee colony collapse, thus adding important evidence to the growing consensus that maladies such as CCD might be the result of a synergism of multiple factors.

Crop Protection & Quarantine

Postharvest irradiation treatment controls light brown apple moth. Since the invasive, light brown apple moth (LBAM) was found in California in 2007, several countries have imposed trade restrictions on some of its host fruits and vegetables. ARS researchers in Hilo, Hawaii, found a radiation dose that resulted in zero tolerance (100 percent control) at the most tolerant LBAM stage. Some countries require zero tolerance to access their markets. This information will facilitate the trade of commodities that are hosts of LBAM.

Cold treatment stops coffee berry borer. Green coffee, which is shipped around the world for custom blending and roasting, carries the risk of spreading coffee berry borer. ARS scientists in Hilo, Hawaii, tested the freezing tolerance of over 15,000 coffee berry borer insects at three different temperatures and determined the temperature and time at which they could control 100 percent of all life stages. Hawaii State regulators are using this information to implement a freezing treatment protocol that allows coffee growers in the infested area to ship green coffee to other islands without the need for methyl bromide fumigation.

New lures for critical pests. The spotted wing drosophila (SWD) is an invasive pest of soft fruits. The brown marmorated stink bug (BMSB) is a pest of many fruits, vegetables, and field crops. Both originated in Asia and are spreading throughout North America. ARS researchers in Wapato, Washington, working with ARS colleagues in Poplarville, Mississippi, and Oregon State Department of Agriculture scientists, isolated and identified a set of chemicals from the odors of wine and vinegar that can be used as a lure for SWD. ARS researchers in Beltsville, Maryland, and Kearneysville, West Virginia, discovered a male-produced pheromone that causes BMSB nymphs and adults to aggregate. Both lures are being combined with traps and will be used to monitor pest populations for treatment and, perhaps, to control the insects via trapping or insecticidal baits. A provisional patent has been filed for the stink bug lure.

Improvement of the sterile insect technique in fruit flies. ARS scientists in Tifton, Georgia, have improved the efficacy of the Sterile Insect Technique (SIT) used to control tephritid fruit flies. They incorporated the juvenile hormone analog methoprene (which coordinates sexual signaling and reproductive development) and a

protein supplement into the diets of adult sterile male flies. Flies fed the protein supplement became sexually mature 4–7 days earlier and thus mated earlier. The males also attracted more wild mates, thus increasing the mating frequency. The International Atomic Energy Agency and Food and Agricultural Organization is including the technology in a coordinated research program to improve the efficacy of SIT. The technology is now used in Mexico to improve the reproductive performance of sterile Mexican fruit flies that have been released to control invasive populations.

New methods using fungus to kill insect pests. Root weevils, soil grubs, rootworms, wireworms, fruit flies, and root maggots are insect pests that affect a wide variety of agricultural crops, landscape plants, and turf. ARS researchers in Peoria, Illinois, developed new methods to grow and commercially produce a bioinsecticidal fungus to kill these pests. The fungus, *Metarhizium*, also kills lesser meal worm larvae and adults, which are pests in commercial poultry operations. Koppert BV has licensed the technology from ARS through a patent. ARS researchers also developed dried granular formulations of *Metarhizium*, which will give homeowners, farmers, and land managers an effective, nonchemical way to control numerous soil-dwelling insect pests.

Stabilization of beneficial traits enhances effectiveness of biological control. Biological control (the use of predators, parasitoids, or pathogens in pest suppression) provides a safe alternative to the use of chemical insecticides. However, during mass production, biological control agents can lose some beneficial traits, such as virulence and reproductive capacity, which can make the agents less effective in pest suppression. ARS researchers in Byron, Georgia, and colleagues at Brigham Young and Rutgers universities, discovered that beneficial trait loss can be prevented by selecting inbred lines. Inbred line technology has been adopted by three commercial companies that produce insect-killing nematodes.

Plant growth bioregulators found to protect pecan foliage from black pecan aphids. Black pecan aphid causes chlorosis (loss of photosynthetic chlorophyll pigment) through its feeding. ARS researchers in Byron, Georgia, found that treating pecan foliage with certain plant growth bioregulators improve canopy health by

lessening chlorophyll degradation by the aphid. Applying a plant growth bioregulator such as gibberellic acid also increases season-long photosynthesis by encouraging longer foliage retainment into the autumn. Return bloom is not affected and there appears to be little or no negative effect on beneficial insects. This new management tool is being adopted by growers. Use of this bioregulator is also applicable to other crops with pests that elicit leaf chlorosis.

New genetic modifications yield "sexing strains" in fruit flies. Mass release of sterile, male fruit flies is used to control the insects, but sterile females released along with males do not contribute to fruit fly control and may distract the sterile males, thereby lowering control rates. Conditional-lethality, in which an insect's offspring dies when certain environmental conditions prevail, is a means of eliminating females early in their embryonic development. Females are not released, and rearing costs are reduced. A conditional-lethal strain of the Caribbean fruit fly was created through genetic modification; females of this strain only survive when provided an antibiotic-(tetracycline) supplemented diet, so only male progeny are produced on an antibiotic-free diet. The genetic constructs involved will serve to improve the efficacy of control programs that protect U.S. agriculture from fruit flies and other potentially invasive pests.

Disrupting insect diapause to control pest insects. A critical life function of numerous pest insects is the dormant state known as diapause, which allows insects to survive winters and other adverse conditions. Entering and exiting diapause is hormonally controlled by an insect's neuropeptides. ARS scientists in College Station, Texas, in collaboration with scientists at Ohio State University, developed stable versions of neuropeptides of the "Diapause Hormone" that are much more active than the insect's neuropeptides. Unlike the native neuropeptide, two of these novel compounds also prevent the entry into pupal diapause or block its termination when administered at the preceding larval stage of the corn earworm, killing the insect. This discovery will be used to develop a novel, practical, and environmentally friendly strategy to control pest insects by disrupting diapause.

Localization of bacterial and fungal pathogens within the southern green stink bug. Southern green stink bugs (SGSBs) acquire several

opportunistic pathogens from environmental sources as they feed. Some of these pathogens are transmitted to cotton bolls, resulting in boll rot, and subsequent yield losses. ARS scientists in College Station, Texas, identified the pathogens transmitted to cotton bolls by SGSBs that are responsible for boll rot. They determined that only two of the many pathogens found in the mouthparts, alimentary canal, or head of the SGSB, are actually transmitted into cotton bolls upon SGSB feeding. This work provides a much better understanding of the role of the SGSB in transmitting pathogens and will be used to develop control measures to improve U.S. cotton yields.

Veterinary, Medical and Urban Entomology

Accurate mosquito trapping results for precise integrated pest management. Integrated pest management requires accurate information on the number of pests and where they are. This is particularly important for mosquito control because resources are always limited compared to the geographic area requiring treatment. Scientists at ARS in Gainesville, Florida compared the number of female mosquitoes captured by suction traps, portable light traps (with carbon dioxide), and landing on a human subject. The results of this research showed that mosquito density from light trap samples was underestimated by 43-97% and over-estimated by 80-85% (depending on species), when compared with the mosquito landing rate on a human subject. Corresponding values for suction trap samples were 28-88% and 17-87%. A statistical algorithm that corrects mechanical trap-based estimates of adult mosquito density to the landing rate of mosquitoes on a human host was constructed. Use of this algorithm will provide a better estimate of mosquito density in a local area which in turn can be used to help mosquito control professionals determine the best method of mosquito control. The algorithm will also enable state and federal authorities to more accurately compare trapping results from different locations. More accurate estimates of mosquito numbers will help authorities target resources, make accurate risk assessments of disease, and assess confidence whether or not invasive species are present.

Bed bugs shown to affect human health. Bed bugs are a blood-sucking pest that lives in homes, hotels, shelters, vehicles, and

businesses. The bugs feed at night causing a variety of reactions from mild irritation to extensive blistering and allergic reaction. Bed bugs had been controlled effectively in the United States since the 1950's until they became much more numerous starting in approximately 2002. They are now a chronic problem in many American cities, especially affecting hotels, shelters, and multi-family homes. In response to stakeholder input in 2007, ARS started a program to study chemical ecology and control of bed bugs at Beltsville, Maryland. ARS participation in the Federal Bed Bug Task Force has facilitated extensive discussions with other agencies, including the CDC. Although the CDC participates, it does not consider bed bugs a public health pest because they do not transmit any pathogens. ARS scientists worked in collaboration with The University of Mississippi Medical Center and Harvard Medical School to show that bed bug bites can cause a very severe, localized inflammation of blood vessels. Moreover, the type of inflammation that occurs has the potential to affect major body organs. These data show that bed bugs are not only an annoyance, but also a health threat. The impact of this research may be greater involvement with proponents of public health in control of the national bed bug problem.

Novel and effective vaccine for cattle against the cattle fever tick.

The southern half of the United States used to be infested with two species of one-host tick that transmitted bovine babesiosis to cattle. The disease is often fatal in adult cattle and is one of the infections that prevents export of live animals. Between 1912 and 1943, the USDA eradicated both species of ticks by systematic programs to dip all infested cattle in pesticide. The ticks are abundant in Mexico and elsewhere in the world, so that APHIS actively fights re-introduction by requiring special treatment of cattle from areas where the ticks still live and by maintaining a quarantine zone in southern Texas between Mexico and the United States. Anti-tick vaccines are an attractive idea for control, both to reduce the amount of pesticide required in eradication programs and to manage tick populations overseas where the ticks continue to be a problem. A vaccine based on a tick gut protein, Bm86, has been available in some countries for over ten years. Recent evaluations performed by ARS in Mission, Texas in cooperation with APHIS showed that the Bm86 vaccine is highly effective against one of the species of cattle fever ticks and

ineffective against the other. Genomic studies and bioinformatics of the cattle fever tick by ARS scientists in Kerrville, Texas produced a series of vaccine candidates based on finding protein sequences likely to cause a strong immune response in cattle. ARS scientists at Kerrville, Texas, in collaboration with EMBRAPA scientists in Campo Grande, Brazil, completed trials of the most promising candidate vaccine antigens. One potential vaccine was 75% effective against the cattle fever tick that was unaffected by Bm86. The mechanism of action of the vaccine was demonstrated by knocking out the target tick gene with RNAi, showing this particular gene was essential for tick survival. This novel antigen was highly expressed in tick nerve tissues, and the results indicate that vaccination against cattle ticks has great potential for integration into APHIS' Cattle Fever Tick Eradication Program and for tick management in contribution toward international food security.

Transgenic screwworm produces only males. The screwworm fly is a damaging pest of livestock that infests wounds and eats living flesh, often killing cattle and other animals. The screwworm fly used to live throughout the southern United States, but was eradicated by the systematic release of sterile male flies that mated with wild female flies, a procedure developed by ARS. Between 1953 and 2005, the program administered by APHIS successfully eradicated the fly from all of North and Central America. Currently, the fly is prevented from reinfesting these areas by continuously releasing sterile males in eastern Panama as a barrier between South America, where the fly still exists, and Central America, where it has been eradicated.

Screwworms are produced in a large factory in Panama, supported by the ARS research program. For the past five years, APHIS funded ARS to develop a transgenic strain of screwworm fly that would only produce males, saving rearing, distribution, and sterilization costs. This project required discovery and insertion of a DNA cassette that was female sex-linked and lethal when tetracycline was not added to the larval medium. In August, 2012 ARS scientists in Kerrville, Texas and Pacora, Panama worked with a collaborator at North Carolina State University to successfully produce a strain in which 99% of females died if tetracycline was not present in the medium. The patient search for the right DNA sequences and the methods to both transform and rear the screwworms produced the strain only a few months later than projected. This strain will allow ARS to prove the

concept of the value of a transgenic, male-only strain, eventually saving APHIS as much as \$5 million per year.

A critical enzyme identified in a sand fly species. Sand flies transmit pathogens that cause a variety of diseases in humans, including verruga, kala azar, cutaneous leishmaniasis, and sand fly fever. Cutaneous leishmaniasis was a major problem for the U.S. military in Iraq and kala azar accounts for hundreds of thousands of childhood deaths in Africa. ARS scientists at Kerrville, Texas identified, cloned, and sequenced sand fly acetylcholinesterase, an enzyme which is the target for many kinds of effective pesticides. Collaborative research with the University of Florida is identifying compounds that closely target sand fly acetylcholinesterase. Such active ingredients will not only be effective, but safe for people and other non-target organisms. These findings offer the opportunity to develop new insecticides for effective sand fly control.

Practical control of sand flies for the military. Old world sand flies are responsible for the transmission of leishmania to humans in areas where U.S. military personnel are currently deployed. Researchers at ARS in Gainesville, Florida successfully conducted the first study examining the efficacy of ultra-low volume (ULV) pesticide applications on Old World sand fly species in leishmaniasis-endemic regions in a natural setting in Africa. These findings indicate that by combining ULV treatments of natural sand fly populations with treatment of camouflage netting, permethrin-treated clothing, and the use of DEET could substantially minimize human-sand fly contact and decrease transmission of leishmania to deployed troops. The outcome of this research leads to disease risk reduction for U.S. military personnel.

Supergene Gp-9 associated with multiple mating and male reproductive success in fire ants. Understanding fire ant male reproductive success and fitness are important components of research aimed at suppressing fire ant populations, yet data on this important topic are virtually nonexistent. ARS researchers in Gainesville, Florida conducted a study aimed at determining how commonly fire ant queens mate with more than one male. This study revealed that some fire ant queens mate with more than one male and that whether a queen mates with more than a single male is

determined almost entirely by male genotype. Investigation of the physiological basis for the inability of some males to discourage a second mating revealed that male sperm count also is linked to male genotype, suggesting fire ant queens remain receptive to mating if their first partner does not provide a sufficient quantity of sperm. Understanding the importance of the male genotype in fire ant colony structure is an important basic discovery that uncovers a new pathway for disruption of this invasive species.

Progress in biological control of fire ants. Imported fire ants are unusually abundant in the United States, probably because they have escaped their natural enemies left behind in South America. ARS researchers in Gainesville, Florida have confirmed the establishment of the new phorid decapitating fly, *Pseudacteon cultellatus*, near Miami and in Gainesville, where it is beginning to expand out of the release area. This new species of fly specializes on attacking the smallest sizes of fire ant workers, which are most abundant in multiple-queen fire ant colonies. This preference is especially important because multiple-queen fire ant populations average 2-3 times the densities of regular single-queen fire ant populations and are therefore a substantially greater pest of homes, agriculture, and the environment. Another species of phorid decapitating fly, *Pseudacteon obtusus*, preferentially attacks larger fire ant workers. This phorid fly was shown to multiply well even in the presence of other species of decapitating flies. This is significant because elimination of the larger worker ants will have a greater negative effect on the colony.

Genomics and biochemistry of termites. The threat of the Formosan subterranean termite to the southeastern United States resulted in a robust research program at ARS on this pest in 1997. Through basic and applied research, cooperation with academic institutions, and a demonstration project, the program successfully solved the problem through areawide integrated pest management and literally saved the French Quarter of New Orleans from destruction. Scientific accomplishments continued through the last year of ARS' termite research, with particularly significant contributions on genomics and biochemistry. ARS scientists in New Orleans, Louisiana performed a project focused on sequencing the Formosan subterranean termite genome and its comparison to the native subterranean termite

genome. This work was performed in collaboration with researchers at the J. Craig Venter Institute and Purdue University. The project completed 18x coverage of the 926 mb genome using Illumina Nextgen sequencing. In addition, ARS scientists identified and characterized a novel endogenous endo- β -1,4-glucanase (named CfEG5) in the Formosan Subterranean termite. Eleven of 15 genes belonging to the metabolic mevalonate pathway were identified. This pathway is responsible for the production of the morphogenic hormone, juvenile hormone, which controls caste differentiation. Further progress was made in understanding caste differentiation by identifying differences in the important musculo-neural protein, myosin, between worker and soldier termites. Basic studies of the biochemistry of carbohydrate metabolism led to discovery of an inhibitor that has promise as a safe pesticide. These basic and applied scientific accomplishments form a foundation for the next work on termites performed outside ARS.

Operational research in support of APHIS' Cattle Fever Tick Eradication Program. The Cattle Fever Tick Eradication Program depends heavily on dipping cattle in solutions of the organophosphate pesticide, coumaphos. An alternative developed in cooperation between ARS and APHIS involves injection of long-acting doramectin. Although injections of doramectin to eradicate cattle fever ticks require half the number of treatments as standard coumaphos dips and significantly reduces costs of regulatory treatments to ranchers, there is concern that repeated injections at 25- to 28-day intervals could eventually reduce efficacy of treatments. In a study at Edinburg, Texas, cattle were repeatedly injected at 28-day intervals throughout the year, with blood serum concentration used as a predictor of the probability of female cattle fever ticks being able to survive and reproduce by successfully feeding to repletion between treatments. Of the two dosages that were tested, the higher dose had a 100% kill rate, and the blood serum concentration never dropped below this level between treatments. Thus, at this dosage it would be impossible for ticks to reach full engorgement between consecutive treatments. Results of this study demonstrated that the trial policy, instituted by the USDA, APHIS, VS, Cattle Fever Tick Eradication Program, of repeatedly treating cattle with doramectin injections at 25- to 28-day intervals for eliminating cattle fever ticks

would produce little or no risk of any viable ticks developing to repletion and re-infesting the field between treatment applications.

Mosquito variation across the nation. The United States is host to over 150 species of mosquitoes and each region has its own group of problem species. A few species occur across the country and are very important as vectors and pests. Two of those species are *Culex tarsalis* and *Aedes vexans*. The former species is a principle vector of West Nile virus in the western United States and the latter is a severe pest and occasional virus vector across the entire country. In spite of the importance of these species, their genetic population structure has never been thoroughly examined. ARS scientists at Manhattan, Kansas have initiated a project to collect many different populations of these species and use the most recent genetic methods to determine population genetic structure. Those methods examine the entire genome of individual specimens to make a thorough comparison of the degree of differences across the continent. More than 86 entities (individuals or agencies) collected 454 unique populations making this one of the largest coordinated collections of disease vector mosquitoes in North America. These mosquitoes will be used to determine the differences between populations of the two species with implications for how to control them and which populations are most likely to transmit pathogens.

Control of mosquito larvae with polyoxyethylene tridecyl ether. Surfactants have been used in soft bodied arthropod control for years, but little is known about the mechanism. ARS scientists at Stoneville, Mississippi found that the combination of both the surfactant chemistry and its specific hydrophilic–lipophilic balance (HLB) number can create the best insecticidal activity against mosquito larvae and pupae. A chemical was found that is highly lethal to mosquito larvae and pupae. Oils are the only products available that kill pupae, but oils are difficult to use and sometimes damaging to plants. A soluble, pupicidal surfactant could prevent emergence of pupae and kill larvae in one step. This product may also be a valuable adjuvant for other pesticides, improving penetration of the cuticle.

Plant Genetic Resources, Genomics and Genetic Improvement

Citrus rootstocks that confer greater tolerance to citrus greening in sweet oranges. Currently, no commercial source of resistance is known for the lethal citrus greening disease, which is widespread in Florida where it severely threatens this important industry. ARS researchers in Ft. Pierce, Florida, compared tree health and fruit cropping for sweet orange trees grafted onto numerous rootstocks in four field trials conducted in a region severely affected by greening. Significant differences in rootstock tolerance of the disease indicated that some rootstocks will enable citrus trees to better tolerate greening disease as one component of successful citrus production management in the presence of that disease.

Methyl Bromide Alternatives

Alternatives to methyl bromide for clean commodities in California. Fumigation for insects is necessary to export many kinds of products and for wholesome domestic products. For decades, industry has relied on methyl bromide for most of this kind of fumigation. The advantages of methyl bromide are that it is cheap, penetrates most packaging and commodities to reach insect pests, and it kills all stages of most insects. Finding alternatives to methyl bromide that are both effective and do not harm commodities is a priority. Experiments conducted by ARS researchers in Parlier, California demonstrated the insecticidal efficacy of sulfuryl fluoride and phosphine, dispensed by a Horn generator. These fumigants appear to be the primary chemical alternatives to methyl bromide for postharvest disinfestations of perishable and durable commodities in California. Fumigants are not the only alternative to methyl bromide. In collaboration with Washington State University, ARS researchers in Parlier, California, have found that a low pressure-low temperature treatment kills codling moth in fresh fruit and results in a higher quality product than when the produce is treated with methyl bromide. This research limits the current need for methyl bromide while protecting American agricultural interests.

Emission reduction with Totally Impermeable Film (TIF). Tarping fumigated fields with Totally Impermeable Film (TIF) can significantly reduce emissions, but can also increase fumigant residence time in soil and require extended tarp-covering durations to reduce potential exposure of workers and bystanders to fumigants. In collaboration

with university researchers and industry, as well as regulatory agencies, a large field study in 2011 found low emission flux of a mixture of chloropicrin and 1,3-dichloropropene (Pic-Clor 60) throughout a tarp-covering period of 16 days with total emission loss <10 percent, and < 1 percent at the tarp edges. Emission flux upon tarp-cutting increased, but was substantially lower than emissions when the tarp was cut 5 or 6 days after covering. This study demonstrated the ability of TIF to significantly reduce fumigant peak flux and total emissions and also documented the need for a longer wait time before tarp-cutting time when using TIF.

Management of red flour beetles in rice mills without methyl bromide.

The red flour beetle is the most important insect pest infesting rice mills, and management has historically relied on structural fumigation with methyl bromide. Because this use of methyl bromide is being phased out under the Montreal Protocol, there is a critical need to evaluate the efficacy of alternative treatments. ARS scientists in Manhattan, Kansas, and colleagues at Kansas State University determined that the average reduction in capture of beetles in pheromone traps after 25 sulfuryl fluoride fumigations in six mills was 66 percent. Beetle captures inside mills tended to follow a seasonal pattern of increased captures in warm months and decreased captures in cool months. Captures inside the mills were correlated with outside captures. The reduction in captures and the rate at which beetle captures returned to pre-treatment levels was strongly influenced by seasonal patterns of insect abundance, a pattern that contrasts with the non-seasonal nature of infestation in wheat mills. These data suggest fundamental differences in red flour beetle populations in rice and wheat mills and that the timing of fumigation is critical for maximizing fumigation efficacy of alternatives to methyl bromide.

Induction of nematode suppressive soil system. The tree fruit producer community needs effective non-chemical strategies for long-term control of plant parasitic nematodes because no nematicides are available for post-plant application. ARS scientists in Wenatchee, Washington, examined pre-plant application of *Brassicaceae* seed meal formulations used in conjunction with a virtually impermeable film for control of apple replant disease and suppression of lesion nematode in two organic orchard systems. Seed meal formulations

provided multi-year suppression of the lesion nematode densities in apple roots to levels significantly below the no treatment control. Although soil fumigation significantly suppressed densities of this nematode during the initial growing season, extensive re-infestation of fumigated soil by the nematode was observed during the two growing seasons to densities dramatically higher than the control or seed meal treated soils. Nematode suppression in the seed meal treated soil was associated with significant changes in soil biology, including increased densities of nematode parasites and predators. This research indicates that a biologically viable alternative to chemical nematicides or soil fumigants can provide extended long-term suppression of plant parasitic nematodes in orchard production systems.

Oxygen and phosphine as an alternative to methyl bromide.

Phosphine is commonly used as a fumigant and it does not degrade the ozone layer as does methyl bromide. The effectiveness of phosphine, whether generated from metallic phosphides or applied in pure form, is not as certain as for methyl bromide. Fumigation of leafy vegetables is a particular challenge because the tissues of the plants are easily damaged by fumigation and must be kept at cool temperatures to assure longevity of the product. ARS scientists in Salinas, California, have discovered that the addition of oxygen to phosphine fumigations greatly increases the effectiveness of this fumigant at low temperatures. Oxygenated phosphine fumigation was demonstrated to significantly reduce treatment time and phytotoxicity and achieve effective control of tolerant insects that cannot be controlled with regular phosphine fumigation. Oxygenated phosphine fumigation has the potential to make significant impact on the fumigation industry and replace the need for methyl bromide in some situations.

Tool to target stored products beetles. Knowing when and where to treat stored products pests is important to limiting the use of fumigation and other pesticide treatments. Accurate surveillance can also increase the effectiveness of integrated pest management by enabling applicators to concentrate efforts where the problem is most severe. ARS scientists in Gainesville, Florida, have developed a new trapping system for stored product beetles. Studies of several species of beetle pests of stored grains showed that all are

preferentially attracted to light at a wavelength of 390 nanometers. Light at the optimum wavelength and a design that took advantage of beetles' tendency to orient towards edges were used to create a trap 20 times better than the current industry standard. Development of this new trapping system significantly improves the ability to monitor stored product pests even when pests are present at extremely low levels. The system promises to significantly reduce pesticide use for control of these pests because instead of whole mill or warehouse fumigation only specific areas need to be treated.

Methyl bromide alternatives for Prunus Replant Disease. Tree growth and yield data collected from 10 orchard replant trials by ARS scientists in Davis, California, demonstrated that broadcast, strip, and GPS-controlled spot fumigation treatments with 1,3-dichloropropene, chloropicrin, or mixtures of the two fumigants provided equal or superior control of Prunus Replant Disease (PRD), compared to soil fumigation with methyl bromide. Pre-plant spot treatments with steam and pre- and post-plant treatments with various fungicides (all applied to tree planting sites) were ineffective.

2. Other ARS Research activities also designed to do no harm:

Invasive species information portal: The National Agricultural Library's National Invasive Species Information Center (invasivespeciesinfo.gov) Web site provides an information gateway to invasive species information; covering Federal, State, local and international sources.

Information management support to ITAP: The National Agricultural Library's National Invasive Species Information Center provides technical and information management support for ITAP, the Federal Interagency Committee for Invasive Terrestrial Animals and Pathogens (itap.gov), a Federal scientific and technical interagency advisory group.

Overseas laboratories/quarantine facilities: Classical biological control is the use of natural enemies derived from a pest's point of origin. It offers the possibility for permanent, cost effective suppression of weeds and insect pests. The ARS Overseas Biological Control Laboratories (OBCL) are located in Australia,

China, Argentina, and France and work as a cohesive network. Their collective mission is to identify, develop and ship natural enemies to stateside collaborators for use in U.S. programs designed to combat invasive species. Accordingly, they represent the beginning of a pipeline of effective biological control agents and numerous stateside programs rely upon them. The ARS OBCL has a rich history of success in this regard, having contributed numerous biological control agents now in use across the U.S. ARS OBCL maintains formal collaborations with APHIS, the U.S. Forest Service, the U.S. Fish and Wildlife Service, the Bureau of Land Management, the Bureau of Indian Affairs, and many State Departments of Agriculture.

Related to this overseas work, ARS maintains quarantine facilities for insects and pathogens that meet Federal safety specifications to preclude pest introduction into the U.S. When beneficial insects arrive from overseas, they are carefully sorted, screened for parasites and reared or cultured within the quarantine facilities. ARS operates laboratories with quarantine facilities in Albany, California, Florida, Maryland, Mississippi, and Montana. Each quarantine facility uses a variety of traps, doors, entryways and sanitizing procedures to keep the pests secure until they are proven safe for release into the U.S.

ARS is represented on the APHIS Technical Advisory Group for Biological Control Agents of Weeds (TAG). The purpose of TAG is to facilitate biological control of weeds in North America by providing guidance to researchers and recommendations to regulating agencies for or against the release of non-indigenous biological control agents. This is based on considerations of potential non-target impacts, conflicts of interest, natural resources, agricultural production, and the Endangered Species Act (ESA) Threatened and Endangered Species List.

ARS is also a member of the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). FICMNEW has representatives from 16 federal agencies with direct invasive plant management and regulatory responsibilities spanning across the United States and territories. FICMNEW members interact on important national and regional invasive plant issues and share information with various public and private organizations participating with the federal sector to address invasive plant issues. It develops

and shares scientific and technical information, fosters collaborative efforts among federal agencies, provides recommendations for national and regional level management of invasive plants, and sponsors technical/educational conferences and workshops concerning invasive plants. FICMNEW continues to bridge the gap between federal agency invasive plant management and science activities and has been a driving force behind the national emphasis against the broader invasive species threat.

ARS is a participant on the North American Plant Protection Organization Biological Control Committee that addresses the movement and regulation of biological control organisms used in either augmentation or classical biocontrol agents intended for release into the environment with expected establishment and pest control.

3. Activities that are doing harm, and future agency actions to change them so that they do not continue to do harm.

None. As the principal in-house research agency for the United States Department of Agriculture, ARS conducts research to develop and transfer solutions to agricultural problems of high national priority. ARS scientific studies provide data and develop tools that enable America to change potentially harmful actions into those that do no harm while still meeting the challenge posed by invasive species.

B. National Institute of Food and Agriculture (NIFA) (previously named the Cooperative State Research, Education and Extension Service- CSREES)

1. Activities to do no harm

Technical Advisory Group for the Biological Control of Weeds: NIFA is a member of the Technical Advisory Group (TAG) for the Biological Control of Weeds. This advisory group is made up of representatives from various Federal agencies that evaluate candidate biological control agents for their economic, environmental, and ecological safety. Should the candidate biocontrol agents receive approval for

release against a given target weed, this helps ensure that harmful non-target effects from the natural enemies are minimized. TAG advises APHIS.

National Animal and Plant Diagnostic Laboratory Networks:

The safety of U.S. plant and animal production systems depends on our ability to rapidly identify foreign pathogens and other pests, whether introduced intentionally (through bio-terrorism) or unintentionally. NIFA has established two national networks of existing diagnostic laboratories to rapidly and accurately detect and report pathogens of national interest and to provide timely information and training to state university diagnostic laboratories.

The National Plant Diagnostic Network is led by five regional laboratories (Cornell University, University of Florida, Michigan State University, Kansas State University, and University of California-Davis) and one support laboratory (at Texas Tech. University).

The National Animal Health Laboratory Network (NAHLN) is led by 12 Core Laboratories and 58 total laboratories (receiving training/reagent/exercise support and being linked) in 43 states. NIFA is currently helping labs (other than the 12 core laboratories) with funding to set up electronic (secure, standards-based) messaging regarding FAD findings. These facilities will help to link growers, field consultants and other university diagnostic labs to coordinate regional detection and provide inter-regional communication in the event of an outbreak. For more information on the NAHLN see http://www.aphis.usda.gov/animal_health/nahln/downloads/NAHLNBriefingCurrent.pdf

2. Other Agency Activities, also designed to do no harm

Integrated Pest Management: Section 15 of the Federal Noxious Weed Act of 1974, and the Executive Order 13112 on Invasive Species (signed in 1999) direct Federal agencies to use an integrated pest management (IPM)

approach for the management of undesirable plants on Federal lands using all available tools, including: education; preventive measures; cultural, mechanical, physical, biological and chemical control; and general land management practices such as revegetation, manipulation of livestock or wildlife grazing, and improvement of livestock and wildlife habitat.

Integrated Pest Management provides a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks. The adoption and utilization of IPM is being encouraged through other legislative authorities within Federal departments. For example, US Code (Title 7, Chapter 6, Subchapter II, Sec. 136r-1. Integrated Pest Management) states: "The Secretary of Agriculture, in cooperation with the Administrator, shall implement research, demonstration and education programs to support adoption of Integrated Pest Management." It further states "Federal agencies shall use Integrated Pest Management Techniques in carrying out pest management activities and shall promote Integrated Pest Management through procurement and regulatory policies and other activities. IPM is also being encouraged across Federal agencies within the Department of the Interior.

Because of the complexity of economic, social, and environmental issues associated with invasive species management, and the biological and ecological attributes associated with each particular invasive species, programs that are based on a combination of technologies tend to be most successful and sustainable. As indicated in the National Invasive Species Council's (NISC) National Invasive Species Management Plan of 2001, the IPM approach considers the best available scientific information, updated target population monitoring data, and the environmental effects of control methods in selecting a range of complementary technologies and methods to implement to achieve a desired objective. Some of the factors to consider in selecting control methodologies include

environmental compatibility, efficacy, cost-effectiveness, inter-compatibility of different types of control measures, practicality and safety. The adoption of an IPM approach for invasive species management will certainly help minimize harm to the environment, human health and wildlife.

3. Activities that are doing harm and future agency actions to change them so that they do not continue to do harm

Pesticide use that has negative impacts: Conventional pest management strategies using pesticides are still emphasized in the management of invasive species with potential negative side effects to humans, the environment and wildlife. NIFA is helping to facilitate the adoption of an Integrated Pest Management Roadmap (IPM Roadmap) that will certainly help minimize harm to non-target species and the environment.

The goal of the IPM Road Map is to increase nationwide communication and efficiency through information exchanges among Federal and non-Federal IPM practitioners and service providers including land managers, growers, structural pest managers, and public and wildlife health officials. Development of the Road Map for the National Integrated Pest Management (IPM) Program began in February 2002, with continuous input from numerous IPM experts, practitioners, and stakeholders. The Road Map identifies strategic directions for IPM research, implementation, and measurement for pests in all major settings, throughout the nation. This includes pest management for areas including agricultural, structural, ornamental, turf, museums, public and wildlife health pests, and encompasses terrestrial and aquatic invasive species.

The goal of the National IPM Program is to increase the economic benefits of adopting IPM practices and to reduce potential risks to human health and the environment caused by the pests themselves or by the use of inappropriate pest management practices.

Pest Management Grant Programs: NIFA has several competitive grant programs designed to emphasize IPM, while reducing pesticide residues on food and in the environment. These include the Pest Management Alternatives Program, Integrated Organic Program, Methyl Bromide Transitions Program, Regional IPM Competitive Grants Program, and the IPM Centers. The emphasis of IPM and bio-based pest management in these NIFA competitive grant programs will certainly help minimize harmful side effects to non-target species and the environment when these strategies are used in invasive species management.

IPM³ Training Consortium for Federal Employees: NIFA, in collaboration with Land Grant Universities and other Federal Agencies, has facilitated the development of an IPM distance education platform to provide IPM training to Federal workers involved in pest management issues and activities. Increasing the quality and consistency of IPM training among Federal agencies and their adoption of an IPM approach for invasive species management will certainly help minimize harm to the environment, to human health, and to wildlife. IPM³ currently offers the following training modules: IPM Core Concepts Module (English); IPM Core Concepts Module (Spanish); Pest Biology Module – Weeds; Pest Biology Module – Plant Diseases; Invasive Species Module; Fire Ant Module; Bed Bug Module; and IPM for Facility Managers and Supervisors; For more information on IPM³ please visit the following website: www.umn.edu/ipm3.

Pest Information Platform for Extension and Education (PIPE): PIPE is a reporting and tracking system, developed collaboratively with the USDA Risk Management Agency, to manage pest and disease information flow via the Web. The PIPE system provides real-time useful information to U.S. crop producers, and a “one stop shopping” center for timely, unbiased, national, and local pest information. PIPE fosters good farming practices by encouraging growers to:

avoid unnecessary or ill-timed chemical applications; use the proper control tactics with the proper timing to manage crop loss risk; and document practices for crop insurance purposes. The PIPE system for soybean rust saved growers hundreds of millions of dollars in 2007 by providing real-time information that enabled the growers to avoid unnecessary chemical applications. Additional active ipmPIPE components include: soybean aphid, legume diseases, curcurbit downy mildew, pecan, and southern corn rust.

C. Economic Research Service (ERS)

1. Activities to do no harm

ERS is the main source of economic information and research from the U.S. Department of Agriculture. ERS research informs and enhances public and private decision-making on economic and policy issues related to agriculture, food, natural resources, and rural development.

Program of Research on the Economics of Invasive Species Management (PREISM): ERS initiated a new program of work in fiscal year 2003, the Program of Research on the Economics of Invasive Species Management (PREISM), to examine the economic issues related to managing invasive species in increasingly global agricultural markets. Through PREISM, ERS primarily funded extramural research through a competitive awards program that focuses on national decision making concerning invasive species of agricultural significance or affecting, or affected by, USDA programs. In addition to ERS-led analyses of invasive species issues, ERS has disbursed \$6.8 million through the competitive awards program to 45 recipients, including universities, other USDA agencies, and private non-profit institutions, for research on the economics of invasive species during FY 2003 to FY 2008. About \$1.1 million per year were allocated for extramural agreements in FY 2005 and FY 2006, while \$950,000 was allocated in FY 2007 and \$970,000 in FY 2008. No Funds were allocated in FY 2009 through FY 2011. ERS also organized

annual workshops from 2003 to 2011 to provide a forum for dialogue on economic issues associated with agricultural invasive species.

Accomplishments of PREISM and outputs of PREISM-funded projects are reported in **Program of Research on the Economic of Invasive Species Management: Fiscal 2003-2011 Activities, which can be access at:**

<http://www.ers.usda.gov/publications/ap-administrative-publication/ap-056.aspx>

Following are some preliminary findings from PREISM-funded research projects:

- Prevention and management resources should be allocated to species and strategies with the highest return (in terms of damage reduction over time). Ideally, marginal benefits and costs should be equal across species and strategies.
- Decision-support tools that follow sound economic principles and reveal underlying scientific assumptions and value judgments provide a basis for expert and stakeholder involvement in decision-making and promote efficient allocations of funds.
- Optimal invasive species management strategies depend upon the stage of the invasion and associated rates of growth and spread. Eradication may be optimal for small invasions; reduction to a containment level for larger invasions. If eradication is feasible, the effort will reduce discounted damages more if it occurs early when populations are small. Delays result in more damages. If total cost increases rapidly as population increases, eradication when the population is small followed by prevention may be the best strategy.
- Under-funded eradication or management efforts can be cost-ineffective or wasteful, with little or no effect on invasive species growth and total damage. Higher initial

expenditures can reduce long term damages and control costs, even if the species is not eradicated.

- For established invasive species infestations, per unit costs of removal can increase as populations decrease or become more isolated, making complete eradication difficult or cost-inefficient. In some cases, accommodation to low levels of invasion is economically preferable to the high cost of eradication. The higher is the cost of removal, the larger the population that will be accommodated.
- Higher invasive species infestation or population growth rates reduce benefit-cost ratios of control efforts, and at high enough rates, control might not be worthwhile. If population has surpassed that of maximum growth rate, the best strategy could be a pulse-like effort that drives populations below a critical population level and growth rate, followed by containment strategy.
- Probability of occurrence maps for invasive weeds based on GIS and other inventory or survey data and related population growth rates can improve weed management efficiency by reducing: 1) costs by targeting sites to monitor invasiveness, and/or 2) damage by initiating control of highly invasive populations before they spread.
- Coordination of regulations across U.S.-Canada, State, and provincial boundaries could: 1) more effectively reduce the cross-border spread of exotic horticultural plants that become invasive, and 2) reduce incentives for cross-border firm relocations to take advantage of more lenient regulations.
- Ecological and agronomic differences influence cross-State differences in noxious weed and weed-seed lists, but stakeholder lobbying also has significant effects.

2. Other Agency Activities, also designed to do no harm

ERS is not engaged in any activities that do harm.

3. Activities that are doing harm and future agency actions to change them so that they do not continue to do harm

None.

II. USDA Regulatory and Resource Management Agencies

A. Animal and Plant Health Inspection Service (APHIS)

1. Activities to do no harm

“Protecting American agriculture” is the basic charge of the U.S. Department of Agriculture’s (USDA) Animal and Plant Health Inspection Service (APHIS). APHIS provides leadership in ensuring the health and care of animals and plants and plays a vital role in ensuring the free flow of safe agricultural trade. The agency improves agricultural productivity and competitiveness and contributes to the national economy and the public health. APHIS has major regulatory authority to implement action programs to achieve these responsibilities.

For more detailed information and up to date highlights of program activity, please visit the APHIS Web Site (<http://www.aphis.usda.gov/>).

Invasive Species Prevention Programs: Specifically the APHIS mission, stated in its current strategic plan, is to protect the health and value of American agriculture and natural resources. To carry out this mission, APHIS works to achieve two interdependent goals:

- Safeguard the health of animals, plants, and ecosystems in the United States (U.S.)
- Facilitate safe agricultural trade

It does so through a system of interdependent objectives addressing exclusion (i.e., prevention), detection, emergency response, management, trade issue resolution, and capacity

building. These areas correspond closely to elements of the 2001 National Invasive Species Management Plan.

APHIS tries to ensure that other entities in the private and public sectors, including other Federal agencies, "do no harm" by introducing or spreading invasive species. APHIS prevention programs – a comprehensive set of risk-based regulations and enforcement efforts -- are directed at animals, plants, and their products that may bring invasive species or be pathways for the introduction of invasive species. As such, the Agency addresses both unintentional and intentional introductions of invasives. A description of some of the applicable regulations follows.

1. Regulation of certain animals and animal products:

APHIS regulates, as set forth in 9 CFR parts 91 through 99, the importation of animals and animal products to guard against the introduction of animal diseases into the U.S. in accordance with the Animal Health Protection Act.

2. Regulation of certain plants and plant products:

Regulations contained in 7 CFR part 319 prohibit or restrict the importation of plants, plant parts, and plant products into the U.S. in accordance with the Plant Protection Act. APHIS enforces the part 319 regulations and considers requests to amend the part 319 regulations to allow the importation of plants, plant parts, or plant products that are not currently allowed importation under the regulations. The requirements apply to many commodities, including nursery stock.

3. Listing of noxious weeds:

Under the authority of the Plant Protection Act, APHIS regulates, in 7 CFR parts 360 and 361, the importation and interstate movement of plants and plant products that may be noxious weeds, i.e., plants that can directly or indirectly injure or cause damage to crops, livestock, poultry, or other interests of agriculture,

irrigation, navigation, the natural resources, public health, or the environment.

USDA APHIS's Website Online Newsroom: this page (http://www.aphis.usda.gov/newsroom/hot_issues/index.shtml) provides links to several 'hot issues' such as efforts underway to eradicate various invasive pests, such as Asian longhorned beetle, as well as general guidance to avoid the introduction or spread of invasive species, such as guidance regarding the transport of firewood or products brought into the U.S. by travelers.

APHIS Plant Protection and Quarantine (PPQ) safeguards agriculture and natural resources from the entry, establishment, and spread of animal and plant pests and noxious weeds into the United States of America; and supports trade and exports of U.S. agricultural products.

Risk Analysis Process

The risk analysis process examines the plant pests and diseases that are known to be associated with a commodity, identifies those pests that are likely to remain on the commodity upon importation into the United States, and evaluates the mitigations that may be required to avoid, reduce, or eliminate the risk of pest introduction into the United States. APHIS conducts risk analyses in accordance with International Standard for Phytosanitary Measures No. 11, "Pest Risk Analysis for Quarantine Pests," and its supplements, set by the International Plant Protection Convention.

Plants and Plant Products Permits

Permits are required for the importation into the U.S. and transit through the U.S. of regulated plants and plant products for consumption or propagation. Plant and plant product permits include plants for planting such as nursery stock, small lots of seed, and post entry; plant products such as fruits and vegetable, timber, cotton and cut flowers; protected plants and plant products such as orchids, and threatened and endangered plant species; transit permits to ship regulated

articles into, through and out of the U.S.; and departmental permits to import prohibited plant materials for research. The permitting system ensures that shippers and importers are aware of which products, and conditions, and allow for safe trade thus preventing the spread of harmful plant pests and disease. This process, along with scientific risk analysis, allows for an ample and diverse food supply as well as safe propagative material.

Crop Biosecurity and Emergency Response

PPQ, the Federal response agency for plant health emergencies, develops and delivers strategic science-based regulatory programs designed to protect US crops and natural resources. PPQ strives to deliver an effective systems approach to mitigate risks posed by select agents and regulated pests.

Accreditation, Certification, and Network Services

The Accreditation, Certification, and Network Services (ACNS) unit manages the National Seed Health System; the U.S. Nursery Certification Program; the U.S. Greenhouse Certification Program; the State National Harmonization Program for seed potatoes; Special Foreign Inspection and Certification programs; Plants in Growing Media; Postentry Quarantine, Audit-based Certification Systems pertaining to section 10201(d)(1) of the Farm Bill; and the National Clean Plant Network pertaining to section 10202 of the Farm Bill.

The Center for Plant Health Science and Technology (CPHST) is the scientific support division for PPQ. CPHST is responsible for ensuring that PPQ has the information, tools and technology to make the most scientifically valid regulatory and policy decisions possible. In addition, CPHST ensures PPQ's operations have the most scientifically viable and practical tools for pest exclusion, detection, and management.

CPHST Plant Epidemiology and Risk Analysis Laboratory (PERAL):

PERAL includes a diverse group of scientists and professionals comprising the primary office in Plant Protection and

Quarantine (PPQ) for pest risk analysis. PERAL is responsible for providing essential scientific support to risk-based policy making across a broad range of phytosanitary issues. The staff uses scientific principles, procedures and evidence to analyze issues relevant to safeguarding plant health from the threats of harmful exotic pests of cultivated and natural plant systems. This includes most risk analyses required by PPQ for pests, Commodities, and pathways but it does not currently include risk analyses associated with plant pest permits, genetically modified organisms, or Federal Noxious Weeds.

PERAL serves a wide range of functions within PPQ. The overarching responsibility is to provide comprehensive, accurate information in support of the decision making process ensuring that resulting actions are the most appropriate and “Do No Harm”. For more in-depth information regarding PERAL, please visit <http://cphst.aphis.usda.gov/planthealth/cphst/peral.shtml>

A good example of one of these functions is the New Pest Advisory Group: The New Pest Advisory Group (NPAG) is located in the APHIS Center for Plant Health Science and Technology (CPHST), Plant Epidemiology and Risk Analysis Laboratory (PERAL). The overall goal of NPAG is to safeguard American agriculture and natural resources. The NPAG assesses new and imminent exotic plant pest introductions into the U.S. to recommend appropriate Plant Protection and Quarantine’s (PPQ) policy and actions to respond to the potential threat posed by such pests. In this case a pest is defined as: *Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products* [FAO, 1990; revised FAO. 1995; IPPC, 1997].

NPAG may address pests in many taxa including arthropods, plant pathogens, mollusks and weeds. It determines whether the pest is a present or an imminent threat, and if the pest meets the definition of a quarantine pest. If the pest meets the definition, NPAG may convene an ad hoc panel of Subject Matter Experts from PPQ, other Federal, state, and university sources with regulatory and scientific expertise for that

particular exotic pest. Through literature searches, data sheet preparation and discussion with the panel, NPAG provides findings and recommendations via the NPAG Report to the APHIS Deputy Administrator and the APHIS Executive Team (represented by PPQ's management) in response to the pest introduction.

Phytosanitary Issues Management

The Phytosanitary Issues Management (PIM) unit facilitates and negotiates, through the use of scientifically based processes, the safe export and import of plant-based agricultural commodities. By so doing, it prevents the introduction of invasive pest species.

APHIS Wildlife Services (WS) Activities

Nonnative, invasive species can be devastating to ecosystems where a lack of natural enemies and competition for resources can allow these species to thrive, wiping out other native wildlife in the process. APHIS WS' efforts target these introduced and invasive species. Invasive species of concern include brown tree snakes (BTS), Gambian rats, nutria, Coqui frogs, pigeons and starlings, house sparrows, feral swine and Burmese pythons.

1. Feral swine are an introduced species that pose a number of threats to humans, livestock and wildlife. Among these threats is the ability of feral swine to harbor a variety of federally regulated pathogens whose presence would result in severe economic loss to livestock industries. Estimates of economic losses from feral swine to agriculture and the environment average \$800 million annually. Feral swine have established populations in 38 states and are spreading rapidly. WS removed 29,427 swine in 31 states in FY 2010.
2. European starlings are an invasive species that invade livestock facilities, eating and defecating in feed bins. This fouling causes severe economic losses to the farmer and transmission of disease and loss of production in the animals. Estimates of economic losses due to starlings range from \$800,000 - \$4,137,119 annually

in the U.S. WS removed 2,511,258 starlings from livestock facilities in 44 states in FY 2010.

3. Brown tree snakes have eliminated 10 of the 13 native bird, most lizard, and bat species on the island of Guam, are responsible for large economic losses from damaged electrical lines and resultant power outages, and pose a hazard to human safety from bites. APHIS continued to prevent the unintentional introduction of the BTS from Guam to other Pacific Islands, Hawaii, and the continental United States in FY 2008. The Agency intercepted 24,920 BTS on Guam or near ports of exit. APHIS WS National Wildlife Research Center scientists at the Fort Collins, Colorado headquarters, conducted an economic assessment of a hypothetical translocation of the BTS from the Territory of Guam to the Hawaiian Islands. The total annual projected economic impact of the translocation of BTS to Hawaii was estimated to fall within the range of \$473 million to \$1.8 billion. These projections underscore the value of a BTS interdiction and control program on Guam.
4. The Gambian rat is a very large rodent native to northern Africa. Gambian rats can harm livestock species and habitats, damage agricultural crops, consume livestock feed, and are associated with a variety of pathogenic diseases that could be spread to humans, livestock, and wildlife. APHIS continues to work with the Florida Fish and Wildlife Conservation Commission, U.S. Fish and Wildlife Service, South Florida Water Management District, and the Florida Park Service to move toward the eradication of the Gambian rat from the Florida Keys. Removal methods have been successful and rat numbers are down significantly over previous years.
5. Nutria are large, semi-aquatic rodents native to South America, but are now established in 17 states and cause extensive damage to wetlands, agricultural crops, and structural foundations such as dykes and roads. The rodents may also threaten human health and safety and serve as a reservoir for tularemia and other diseases. APHIS is leading the first large-scale North American effort to eradicate a mainland population on the Delmarva Peninsula in Maryland where the rodents have devastated coastal

Chesapeake Bay marshes. In cooperation with the Department of Interior's U.S. Fish and Wildlife Service, Maryland Department of Natural Resources, U.S. Geological Survey (USGS), Tudor Farms (a 6000-acre private wildlife management area) and 300 private landowners, APHIS has completed the initial nutria removal from more than 150,000 acres of coastal marsh in Maryland. The Agency is now expanding the search for established populations in major tributaries leading into the region. The Agency's wildlife specialists have developed and refined new removal techniques and have partnered with USGS to develop new detection and monitoring techniques including remote triggered cameras, call-back surveys, and other means of detecting low density populations. Through careful population monitoring, APHIS has successfully prevented the re-infestation of this area, and marsh grasses and native muskrat populations are quickly recovering throughout the previously-impacted area.

In addition to the species highlighted, APHIS provides assistance to the general public upon request to resolve damage caused by invasive species. Last Fiscal Year, APHIS provided direct control assistance to resolve damage caused by 14 of the 23 bird, mammal, and reptile species identified by the World Conservation Union (IUCN) as being among the top 100 invasive species in the world. These species included: BTS, giant toad, Coqui frog, red-vented bulbul, common myna, European starling, nutria, house mouse, roof rat, small Asian mongoose, feral swine, cats and goats.

APHIS Veterinary Services (VS) Activities

1. National Animal Health Laboratory Network (NAHLN) is a state-federal cooperative effort including the APHIS National Veterinary Services Laboratories, which provide reference and confirmatory laboratory services including training, proficiency testing, and prototypes for diagnostic tests. The State/University laboratories in the NAHLN perform routine diagnostic tests for endemic animal disease as well as targeted surveillance and response testing for foreign animal diseases. The network will assist in early detection and rapid, scalable response to an exotic animal disease. For example, over 40 laboratories have been trained and proficiency tested to

perform foot and mouth disease (FMD), avian influenza (AI), and exotic Newcastle surveillance diagnostics. A surveillance program for classical swine fever (a vesicular disease present in the Dominican Republic and Haiti) was established using NAHLN laboratories.

2. Cattle fever is a severe and often fatal disease of cattle transmitted by two species of tick. The ticks were eradicated from the continental United States in 1943, with the exception of a buffer zone between Texas and Mexico. An increase in movement of deer and stray livestock across the border has led to increased fever tick infestations in recent years despite a partial tick control border fence, livestock movement quarantines, and tick treatments for cattle and deer. APHIS is collaborating with ARS and the Texas Animal Health Association to explore alternative methods of tick control including baiting stations with acaricide-impregnated rollers and anti-tick vaccines (see ARS section above).
3. APHIS continues to cooperate with CDC, State animal and public health officials in response to swine influenza spillovers into humans (and vice-versa). Epidemiology, virus sequencing and characterizations are performed to assess the risk of establishment and spread within the species.
4. Foot and Mouth Disease is the most communicable disease known, and is exotic to the United States. APHIS activities have recently included vaccine and pen-side diagnostics studies, characterizing the pathogenesis and clinical signs in feral swine, and examining susceptibility of U.S. wild ruminant species. Validation of bulk-tank milk testing, virus-inactivating sample collection paper (allowing increased laboratory capacity) studies are ongoing.
5. The policy regarding FMD vaccination vs. stamping out has shifted to make vaccination more likely in a large outbreak, in turn making eradication more likely in multiple scenarios. “Safe-Egg” and “Secure Milk Supply” plans for AI and FMD are being developed with commodity groups and universities,

making compliance more likely, in turn making eradication more likely.

6. Rift Valley Fever is an arthropod-borne zoonotic disease (infects humans and non-humans) of Africa. U.S. mosquito species have been proven competent. APHIS activities have recently included diagnostic test validation, geospatial collaborations, and vaccine approval advice and steps.
7. Nipah virus is spread from fruit-eating bats to swine and can also infect humans (from bats or swine). APHIS has collaborated with other agencies regarding vaccine approval advice.
8. APHIS has changed regulatory requirements for surveillance and pre-movement testing of livestock for brucellosis and tuberculosis after consultation with states, tribes, and the animal industry. In the United States, these diseases of wildlife, livestock and humans currently exist only in limited wildlife foci. The changes should allow more efficient use of resources to allow continued control of the disease.
9. APHIS is partnering with university and industry entities to increase the value of its disease spread modeling programs by adding livestock movement data. An exotic or emerging animal disease would likely move most quickly through current production-oriented animal movement.
10. A 'dashboard' allowing visualization of sampling, outbreaks, response measures, laboratory capacities, etc., has been developed in collaboration with Department of Homeland Security (DHS) and one of their Centers of Excellence, which should allow syndromic surveillance (earlier detection) and more rapid and effective response to foreign and emerging diseases.

APHIS International Services

APHIS International Services (IS) supports APHIS' mission of protecting U.S. agriculture and natural resources in an international environment. An important IS activity is international

capacity-building to prevent the introduction of exotic pests and diseases.

Under 7 CFR § 371.8, IS is responsible for "monitoring and reporting the presence and movement of plant and animal diseases and pests in foreign countries." IS' field employees are the "eyes and ears" for the early detection and confirmation of emerging threats to U.S. agriculture. These employees are a critical component of APHIS' combined activities in detection and reporting of exotic threats, and all technical IS employees are expected to dedicate part of their time to these activities. These functions are part of IS' broader obligations to meet the APHIS mission in safeguarding U.S. agriculture, and surveillance activities are a routine function of IS personnel stationed overseas. The information provided by IS is used by the other APHIS program units (chiefly Veterinary Services and Plant Protection and Quarantine) and may result in changes in regulatory status, entry requirements, etc.

IS performs various training programs abroad to enhance technical, administrative, and diplomatic skills and competencies. IS contributes to international technical capacity building by supporting development of other countries' diagnostic and species identification resources. For example, IS distributed new Lucent keys to international partners (ie IICA, FAO, CARDI, CABI, OIRSA) and national plant protection organization (NPPO) counterparts via IS offices overseas. IS also forwarded the new identification materials/links to the University of Florida (UF) for dissemination to diagnosticians in the Caribbean Pest Diagnostic Network (CPDN) (which includes five countries where IS provided distance diagnostic equipment). The new keys were included in the resource materials provided to participants in the Regional Plant Quarantine Officers class funded by PPQ Greater Caribbean Safeguarding Initiative (GCSI) and given at the University of the West Indies (UWI) in Trinidad (in 2011 and 2012).

IS organized numerous capacity building trainings and workshops to train international NPPO inspectors and identifiers, to enable them to identify new pests entering their countries or to identify indigenous pests in phytosanitary export inspections (prior to

export to the United States). Just two examples include training in Asian Gypsy Moth Surveillance in Chile and a Giant African Snail Workshop in the southern half of South America.

2. Other Agency Activities, also designed to do no harm

Program protocols: APHIS also follows protocols to ensure that its own activities and those of its State cooperators, carried out to exclude, detect, diagnose, control, and eradicate invasive species, do not contribute to the problem. These ongoing efforts include, in a general sense, agency personnel adherence to established biosafety procedures in programs to detect, diagnose, and conduct control operations for plant and animal diseases and pests, both in laboratories and in the field; and assessment, in advance, of the probable impact of the use of biocontrol agents in programs to control invasive species.

3. Activities that are doing harm, and future agency actions to change them so that they do not continue to do harm

None. APHIS actions are consistent with the “DO NO HARM” objective of the Presidential Executive Order on Invasive Species.

B. Natural Resources Conservation Service (NRCS)

1. Activities to do no harm

The NRCS is well aware of the past, the present, and the potential future harm to the private lands in the U.S. from invasive species. The negative environmental and economic impacts of invasive species continue to be a large and growing problem for our Nation’s private landowners.

The primary invasive species focus for NRCS has been on terrestrial and aquatic invasive plants. Invasive plants have had large negative environmental impacts upon the intended uses of many privately owned lands and wetlands in the U.S. There have also been large negative economic impacts

associated with the costs of invasive plant control. Invasive plants compete for soil nutrients and water in croplands and wild lands and often require the use of herbicides, biological control agents, or innovative control techniques. Invasive plants, often of poor forage quality, may out-compete native plants in grazing lands and wild lands rendering large acreages no longer useful for supporting livestock or wildlife. Invasive aquatic plants rapidly spread in water bodies and wetlands, removing the open water component necessary for many wildlife species. Of particular concern are the negative impacts from invasive plants, invasive invertebrates, and pathogens upon populations of native and introduced pollinators and their habitats as well as upon native threatened or endangered species and their habitats. The invasive species could have devastating effects on desirable cropland and wild land plants and animals.

Publication and Revision of Agency Invasive Species Policy:

NRCS published its NRCS Invasive Species Policy in November 2004 and revised it in July 2010. The policy is available at

<http://policy.nrcs.usda.gov/ViewRollUp.aspx?hid=17018&sf=1> The policy addresses the invasive species responsibilities at all levels (e.g., National Headquarters, Regional, State, and Field offices) of the agency. It requires awareness by NRCS employees of the presence of invasive species and potential problems associated with them. It requires NRCS to work with partners and to use its human and financial resources for control, suppression, and/or eradication of invasive plants. The policy also requires that native plant species be used in vegetative conservation practices unless it can be demonstrated that no native species can achieve the desired conservation goals, or the desired native species is not available in the quantity required. Interim use of non-native, non-invasive species is allowed to provide the conservation function desired until native species can be established.

Assisting in the control and eradication of invasive plants:

NRCS provides U.S. private landowners with financial and technical assistance to control and/or eradicate invasive plants

in an effort to maintain the desired vegetation (e.g., food crops and forage), to maintain the desired characteristics of the land (e.g., wetland open water), and to diminish invasive plants spreading to neighboring lands. NRCS frequently partners with local and regional weed control organizations for control of weeds on and off private lands. The agency encourages the use of integrated pest management (IPM) which may involve appropriate herbicides when necessary, the use of approved biological control organisms, and innovative cultural control methods for specific problems (e.g., black plastic). NRCS has placed increased emphasis upon the protection of wildland habitats for pollinators and other wildlife

Landowners that participate in some of the easement programs of NRCS (e.g., Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP)) are required to control invasive plants that might infest the easement lands. CRP and WRP participants may receive some financial assistance to maintain these lands free of invasive plants. The Wildlife Habitat Incentives Program, Environmental Quality Incentives Program and the Conservation Stewardship Program also provide technical and financial assistance to help private landowners control invasive plants.

NRCS Conservation Practice Standards: NRCS has created a toolbox of 170 practice standards that provide guidance for applying conservation technology on the land and that set the minimum levels for acceptable application of the technology. These practice standards undergo periodic review for incorporation of new technology (generally every 5 years). Emphasis continues to be placed upon the identification and consideration of the potential invasive qualities of recommended vegetation, the use of native vegetation, and the protection and enhancement of pollinator habitat.

The NRCS Plant Materials Centers (PMCs): The 27 PMCs nationwide cultivate and provide seed stock of plants that are used for vegetative conservation practices within the geographical region served by each PMC. The PMCs encourage use of native plants, particularly source-identified

plants, for restoration, reclamation, and conservation practice uses. The Plant Materials program uses an Environmental Evaluation to assess the potential invasiveness of plants being considered for release. If the potential for invasiveness is too great, other plants considered less potentially invasive for the particular environmental conditions are recommended.

The PMCs also used the Environmental Evaluation to review all prior NRCS conservation plant releases. For plant releases that were determined to be invasive or otherwise environmentally harmful, the PMCs discontinued their production. Once a PMC discontinues a plant release, the NRCS plant materials specialists work with the appropriate states to remove the invasive plant releases from NRCS State standards and recommendations so the plant is not recommended in the future.

2. Other Agency Activities, also designed to do no harm

PLANTS Database: The information about plant materials available through the PLANTS database (<http://plants.usda.gov>) is useful to conservation professionals and the public in determining beneficial plants that do well within a particular geographical location. It also has information on plants which should not be planted within a particular environment (e.g., Federal and State noxious weed lists). The database information provides help to assess the potential invasiveness of specific plants. The PLANTS database has over 650 fact sheets on-line and provides services through over 70,000 user sessions per day. It encourages the use of native plants in conservation practices. Future capabilities will include information about the pollinators upon which specific plants are dependent, and recommended forage to encourage specific pollinators.

3. Activities that are doing/have done harm, and agency actions to change them so that they do not continue to do harm

Recommending invasive plants in conservation plans.

During the “Dust Bowl” days of our nation, immediate action was necessary to mitigate excessive wind and water erosion of our nation’s soils. Unfortunately, one of the mitigation tools that worked effectively was the use of non-native plant materials, some of which became invasive and presently are among the invasive plant materials we are trying to control. The use of the Environmental Evaluation by the PMCs before recommending specific plant materials for conservation is proving to be beneficial to avoid present and future problems of this kind. Also, encouraging the use of locally-acquired native plants whenever they can meet the conservation needs is enhancing awareness to NRCS state and field offices about invasive species problems and NRCS responsibilities.

The implementation of the NRCS Invasive Species Policy has made clear to all levels of the agency the responsibilities to respond to invasive species problems, and to minimize or avoid future invasive species problems.

The state-specific Field Office Technical Guides provide technical guidance information for the specifics of each conservation practice standard within the specific State. Technical Guides may, in some cases, still recommend the use of plant materials that, in some situations, may have the potential to become invasive. NRCS has conducted and continues a review of all vegetative conservation practice standards to identify where this situation exists, and to work with the appropriate PMCs and State Plant Materials Specialists to recommend other appropriate and non-invasive plant material.

Use of herbicides or other methods that may have detrimental effects on native pollinators: The treatments recommended in some conservation practice standards for invasive plants may, in some cases, include the use of herbicides or other methods that may have detrimental effects directly or indirectly (e.g., habitat destruction) on native pollinators. NRCS continues to review and to revise all practice standards to identify such methods, and to recommend revisions that minimize or

eliminate negative impacts to native pollinators. NRCS is developing a module within the PLANTS database that identifies specific plant-pollinator relationships and encourages the use of “pollinator friendly” plants in agricultural and wild land situations.

C. U.S. Forest Service (FS)

1. Activities to do no harm

Policy Development - For invasive species management in National Forests and Grasslands: The proposed new Forest Service Manual (FSM 2900) for invasive species management on the National Forest System was finalized in FY12 and implementation has begun.

Policy Development - NFS Invasive Species Management Handbook: The new Forest Service Manual 2900, will tier into an accompanying Forest Service Handbook (FSH 2909.11 – NFS Invasive Species Management Handbook) is being developed. A national team was established to build the draft content; which will articulate specific guidance, standards, criteria, rules, procedures, including, but not limited to: 1) Roles and Responsibilities for Invasive Species Management on the National Forest System, 2) Integrated Management Guidance, 3) Invasive Species Prevention and Control Procedures, 4) Invasive Species Early Detection and Rapid Response Criteria and Procedures, 5) Internal and External Coordination, 6) Record Keeping and Reporting, 7) Invasive Species Management Planning and Environmental Compliance/NEPA, 8) Contract and Permit Requirements and Related Oversight, 9) Inventory, Survey, Monitoring and Treatment Protocols, and 10) Invasive Species Management Program Training Requirements and Standards. The development of the new policy (Handbook) continued in FY2012 and FY 2013.

Updated USFS National Invasive Species Program Web Site: USFS updated the portals, navigation, and content for the national website on invasive species. It provides user information on FS activities related to invasive species, policy,

authorities, news and emerging issues. The site provides key contact information for invasive species program managers, access to cooperative projects and research, geographic information, species profiles, and techniques for preventing and controlling a wide variety of species. The website is <http://www.fs.fed.us/invasivespecies/>

Research on invasive species:

Nationwide, state and federal agencies invest sizable budgets to look for and eradicate newly established non-native forest insects and diseases such as the emerald ash borer, hemlock woolly adelgid, or oak wilt. R&D scientists developed a new planning tool that helps organizations prioritize where to look for newly established populations and how much to spend on surveillance while minimizing the damage caused by invasive species. The tool helped evaluate the surveillance program for gypsy moth in California. They found that allocating surveillance effort across counties in proportion to surveillance cost and gypsy moth establishment rate could save the state over \$200,000 annually in surveillance and eradication expenditures.

Chinese tallow is outcompeting native trees near wetlands where frogs breed. The greater the concentration of tallow leaf litter in water, the lower the dissolved oxygen and pH levels. Southern leopard frog eggs in early stages of development did not survive exposure to any tallow leaf litter concentration. Eggs in later stages of development only survived to hatching in low concentrations of tallow leaf litter.

High elevation white pine forests are valued by people for their aesthetics, longevity, their ability to survive at high altitudes, their capture of snow in the headwaters of western Northern American watersheds, and their seeds which serve as food for many wildlife species. These forests are threatened by the non-native lethal disease white pine blister rust, a disease that already impacts many western ecosystems and threatens the sustainability of the species. R&D scientists and partners developed a proactive management strategy to sustain healthy high elevation pine populations and mitigate the impact of white pine blister rust. Implementation of the strategy in high

elevation pine forests, under the threat of multiple stressors, is an excellent example of proactive management for ecosystem resilience.

Scientists developed a manual that explores use options for trees killed by invasive insects. Researchers present a summary of options, such as high-value wood products, for using hardwood trees killed by invasive species. The publication places a major emphasis on trees killed by the emerald ash borer. This user-friendly guide focuses on how best to use wood obtained from trees that were infected by invasive species. *Assessing Wood Utilization Options for Urban Trees Infected by Invasive Species* is a comprehensive manual that can be used by professionals when assessing use options for this material. The publication includes a summary of the technical viability of using these materials for value-added products in a variety of applications, and will be useful to urban foresters, municipalities, and local industries looking for ways to use beetle-killed trees.

Burning and thinning treatments are being increasingly used in western forests to manage insects and disease and reduce wildfire hazards. Unfortunately, these treatments can trigger the invasion and spread of invasive plants—something that could thwart successful restoration efforts. Noxious weeds were monitored following thinning and burning treatments in a lodgepole pine forest in central Montana. Surveys were made in the treatment units and along roads. Five species listed as noxious weeds in Montana were recorded: spotted knapweed (*Centaurea stoebe*), oxeye daisy (*Leucanthemum vulgare*), Canada thistle (*Cirsium arvense*), common tansy (*Tanacetum vulgare*), and houndstongue (*Cynoglossum officinale*). With the exception of Canada thistle, noxious weeds were confined to roadsides and did not colonize silvicultural treatment areas. This highlights the importance of roads for weed distribution and spread, and it suggests that roadways should be considered when evaluating the potential for invasion of exotic plants following restoration treatments. In this forest, weed control along adjacent roads and in heavily disturbed areas

such as slash piles may be a cost-effective and efficient tactic to limit exotic plant invasions.

The Hawaii Department of Agriculture and USDA Forest Service conducted the first field release of a biocontrol agent for strawberry guava in Hawaii beginning in December 2011. Releases to build populations of the biocontrol agent have continued at two Hawaii island demonstration sites where effects of the highly host-specific leaf-galling scale insect *Tectococcus ovatus* are being carefully monitored. The insect was imported from its Brazilian native range and studied over the past decade to determine its suitability for introduction to manage strawberry guava, a widespread and devastating invader of native rainforests. Initial establishment of galls in the field has been slowed by unusually cool temperatures, but gall development has increased rapidly with the onset of summer. Potentially reproductive galls appeared in July 2012, providing the first indication of a self-sustaining population. These first establishment sites will serve to demonstrate the specificity and impact of the agent and will be used to generate insects for further releases in native forests, where biocontrol is intended to slow the spread of strawberry guava and complement other approaches for long term management.

USFS R&D is working to improve our use of the internet to disseminate research results. Our national office website was redesigned to provide a “one-stop” umbrella for research programs in all the research stations. See:
<http://www.fs.fed.us/research/invasive-species/>

2. Other Agency Activities, also designed to do no harm

Reprinting of USFS DVD's on Invasive Species Prevention:
The second and third videos in the USFS DVD series on invasive species prevention best management practices were reprinted and released to the public. Both “Defending Favorite Places – How Hunters and Anglers Can Stop the Spread of Invasive Species” and “Playing Smart Against Invasive Species – How to Enjoy and Protect the Great Outdoors” have been high demand as valuable educational tools for all sectors. All

the videos in the series are available on the web at <http://www.fs.fed.us/invasivespecies/>.

Evaluation of vehicle washing activities: The National Forest System continues to support the evaluation of vehicle washing activities/systems/protocols with public and private partners to evaluate the effectiveness of existing systems and mechanisms. Evaluations are based on a scientific approach to quantify effectiveness and determine treatment quality for various scenarios. Long term objectives of the project include building better protocols and contract specifications, and ultimately better effectiveness at preventing the spread of invasive species by equipment and vehicles.

NFS Performance measures for invasives: The National Forest System maintained strong performance and accountability system measures for all invasive species program activities, nationwide. Field data was collected in corporate data management applications, and validated per the business rules and requirements. Program performance is outcome-driven and will emphasize the effectiveness of treatments. All NFS invasive species program performance outputs and outcomes were incorporated into the Forest Service Performance Accountability System for upward reporting in FY 2012.

Prevention language in FS contracts: In FY 2012, the National Forest System continued to use specific invasive species 'prevention' language which may be included in project contracts, agreements, and permits (such as timber sales, road management, facility construction, easements, grazing allotments, maintenance of right-of ways, facility operations, etc.) that specify requirements to minimize or prevent invasive species infestations and spread on national forests and grasslands.

3. Activities that are doing harm, and future agency actions to change them so that they do not continue to do harm

None.